

1. Project Title:	2. Date:	3. Person Responsible
SPHENIX	01/15/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10	Installation and Integration

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Summary Item - Rolls up costs from WBS Items 1.10.01 through 1.10.03</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Includes Project Management and technical Coordination, Tooling, Fixtures and Procedures design, and assembly, installation and commissioning (in building 1008) of infrastructure and detector subsystem components.</p> <p><u>WORK STATEMENT:</u></p> <p>See Subtasks</p>

1. Project Title:	2. Date:	3. Person Responsible
SPHENIX	01/15/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10.01	Integration management and technical coordination of Assembly and Installation activities

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Labor cost only, no material. Labor based on engineering estimates of effort required to perform the tasks as described in this section..</p> <p><u>TECHNICAL CONTENT:</u></p> <p>This task includes all scientific, engineering and technical staff efforts to plan and supervise all aspects of the assembly, integration and installation of the sPHENIX infrastructure components (defined by WBS 1.09), completed and tested detector subsystem modules and electronics (defined by WBS 1.04 though 1.08), and sPHENIX superconducting solenoid magnet (defined by WBS 1.03) at 1008</p> <p><u>WORK STATEMENT:</u></p> <p>Supervise, guide the scientific and engineering management of sPHENIX assembly, integration and installation tasks and develop the associated plans for those same tasks as follows:</p> <ol style="list-style-type: none"> 1. Subsystem Interface & Integration Plan - Plan to describe and define all interfaces between WBS subsystems., including detector mechanical interfaces, electrical interfaces, conduits and cable routing management, space allocation, cooling (water and air), detector cryogenic, inerting, drying, etc. gas supply routing and interfaces. Deliverable: written document, (note: related schematic drawings created in

Infrastructure WBS item 1.09)

2. Subsystem Initial Envelope Drawing - Drawing to globally define space allocation for detector subsystems, infrastructure, support services and potential future additions.

Deliverable: Drawing

3. Subsystem Final Envelope Drawing(s) - Drawing set of individual envelope drawings for each detector subsystem

Deliverable: Drawings: estimated at 5 drawings

4. Cable Management Plan - Overall plan for routing electrical and optical, power, signal, control and monitoring cables between detectors to control racks, front end modules, patch panels, data acquisition, etc.

Deliverable: written document

5. Survey Plan - Overall plan for alignment and positioning of overall detector relative to nominal beam orbit, individual detector subsystems to the overall detector, and internal alignment and positioning of detector subsystem internal components to the subsystem overall alignment.

Deliverable: written document

6. Integration & Installation Review - Engineering and safety review of individual plans above.

Deliverable: written report

7. Integration Supervision - Management and supervision effort to guide the project through all individual tasks and assure adherence to schedule and budget allotments.

Deliverable: none

1. Project Title:	2. Date:	3. Person Responsible
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4. WBS Element Code	5. WBS Element Title
1.10.02	Integration/Installation Tooling/Fixture/Procedures Design and Production

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Labor and material costs for the design and production of Tooling, Fixtures and Procedures for the items listed in the technical content below. All costs are based on engineering estimates</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Analyses, design and creation/fabrication/procurement of tooling, fixtures and procedures of the following items:</p> <ul style="list-style-type: none"> 8. CP Carriage Integration/Installation 9. sPHENIX SC Magnet Integration/Installation 10. Outer HCal Integration/Installation 11. Inner HCal Integration/Installation 12. EMCal Integration/Installation 13. Tracking Integration/Installation <p>(Note: tooling, fixtures and procedures for the assembly of modules and sub-module components of the various detector subsystems, magnet related components are not covered in this item. See the WBS dictionary entries for those subsystems for that information)</p>

WORK STATEMENT:

The tasks required for the integration, installation and assembly performed at PHENIX building 1008 are as follows:

1. CP Carriage Integration/Installation : Design analyses, drawings, procedures, procurement and fabrication of tooling for the assembly and installation of the CP carriage including base, roller supports, HCal cradle magnet mounting feet, platforms and access stairs.
Deliverables: Drawings (estimated 3 assembly drawings 3 schematics), plans and work permits, custom tools and fixtures
2. sPHENIX SC Magnet Integration/Installation : Design analyses, drawings, procedures, procurement and fabrication of tooling for the installation and integration of the sPHENIX SC magnet into the CP including cryo and electric integration, alignment/survey to CP, and full field test/commissioning of the magnet.
Deliverables: Drawings (estimated 1 assembly drawing, 3 schematics and 3 detail drawings), plans and work permits, custom tools and fixtures
3. Outer HCal Integration/Installation: Design analyses, drawings, procedures, procurement and fabrication of tooling for the installation/integration of the Outer HCal detector into the CP, power control and signal integration and commissioning of the detector, including alignment to the nominal beamline orbit and the magnet.
Deliverables: Drawings (estimated 1 schematic), plans and work permits, custom tools and fixtures
Deliverables: Drawings (estimated 1 schematic), plans and work permits, custom tools and fixtures
4. Inner HCal Integration/Installation : Design analyses, drawings, procedures, procurement and fabrication of tooling for the installation/integration of the Inner HCal detector into the CP, power control and signal integration and commissioning of the detector, including alignment to the nominal beamline orbit and the magnet.
Deliverables: Drawings (estimated 1 schematic), plans and work permits, custom tools and fixtures
5. EMCal Integration/Installation : Design analyses, drawings, procedures, procurement and fabrication of tooling for the installation/integration of the Inner HCal detector into the CP, power control and signal integration and commissioning of the detector, including alignment to the nominal beamline orbit and the magnet.
Deliverables: Drawings (estimated 1 schematic), plans and work permits, custom tools and fixtures

6. Tracking Integration/Installation : Design analyses, drawings, procedures, procurement and fabrication of tooling for the installation/integration of the Tracking detector into the CP, power control and signal integration and commissioning of the detector, including alignment to the nominal beamline orbit and the magnet.

Deliverables: Drawings (estimated 1 schematic), plans and work permits, custom tools and fixtures

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SPHENIX	01/15/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10.03	sPHENIX Installation

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Summary Item - Rolls up costs from WBS Items 1.10.01 through 1.10.03</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Includes assembly of Central Pedestal Carriage installation of Outer HCal, sPHENIX superconducting solenoid magnet, Inner HCal, EMCal, Tracker, Flux return end caps and all infrastructure and services to the detector subsystems and magnet. Also includes testing and commissioning of all detector subsystems as described in the subtasks, a full field test and full magnet mapping of the sPHENIX SC magnet with the Outer HCal (only) installed, and a final full field test and partial magnet mapping with all detector subsystems installed.</p> <p><u>WORK STATEMENT:</u></p> <p>See Subtasks</p>

1. Project Title:	2. Date:	3. Person Responsible
SPHENIX	01/16/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10.03.01	Infrastructure Installation

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Labor and material costs for the Installation of the infrastructure items listed in the technical content below. All labor and material costs are based on engineering estimates</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Installation and integration of the sPHENIX Infrastructure subsystems and subsystem upgrades (Line electric, cryogenics supply, beampipe/vacuum, IR HVAC, electronic cooling water, safety subsystems, detector support services, detector access and non-IR infrastructure) with the sPHENIX detectors and support carriage.</p> <p><u>WORK STATEMENT:</u></p> <p>For each of the subsystems indicated carry out the indicated tasks to install/modify the subsystem components as follows:</p> <ol style="list-style-type: none"> 1. Line Electric <ol style="list-style-type: none"> a. Main breakers b. lines to carriage subbreakers c. distribution lines to lighting, outlets and rack power 2. Cryogenics support <ol style="list-style-type: none"> a. structural supports for Cryo transfer lines to carriage b. structural support for cryo lines on carriage c. mounting and structural support for dewars 3. Beampipe/Vacuum

- a. Install temporary beampipe and beampipe supports for BES runs
- b. bake out temporary beampipe
- c. Install beampipe supports and alignment adjustments
- d. Install central (beryllium/aluminum/stainless) beampipe, north and south 40 mm ID to 3 inch OD transition (stainless) beampipes, pump out ports and isolation valves, north and south, bellows, north and south, 3 inch OD to 5inch OD transition (stainless) beampipes, and extension spool beampipes.
- e. bake out all beampipe segments and activate NEG coating
- 4. IR HVAC
 - a. Install upgrades and replacement components
 - b. Install monitoring lines and equipment
- 5. Electronics cooling water
 - a. adapt existing supply and return to new primary distribution manifolds
 - b. Install piping to carriage distribution manifolds
 - c. Install carriage distribution manifolds
 - d. connect to end users (e.g. rack fan tray heat exchangers)
 - e. leak check all lines
- 6. Safety Subsystems
 - a. Modify existing safety equipment
 - b. Install new safety equipment
 - c. test existing, modified and new equipment
- 7. Detector support services
 - a. Install cable trays and cable tray support hardware
 - b. Install all cables, fibers, monitoring and control lines
 - c. Install dry air, and N2 lines and support hardware
 - d. Install Racks (mechanical, connect electrical, plumbing and safety system equipment)
- 8. Detector Access
 - a. Install rack platform access stairs and safety rails
 - b. Install Bridge access ramp from permanent stair platforms to Central pedestal carriage.
- 9. non-IR infrastructure
 - a. Install AH infrastructure modifications/upgrades
 - b. Install Rack Room Upgrades and new DAQ equipment (see 1)
 - c. Install Control Room modifications/upgrades
 - d. Install Gas Pad modifications/upgrades

Deliverable: None (Milestones for item completions and deliverables in WBS 1.09)

1. Project Title:	2. Date:	3. Person Responsible
SPHENIX	01/15/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10.03.02	CP Carriage Assembly

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Labor and material costs for the Installation of the Central Pedestal Carriage and structural integration components items listed in the technical content below. All labor and material costs are based on engineering estimates</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Assembly and installation of the CP carriage including base, roller supports, HCal cradle magnet mounting feet, platforms and access stairs.</p> <p><u>WORK STATEMENT:</u></p> <p>The tasks required to implement the assembly and installation of the CP carriage and structural Integration components are as follows:</p> <ol style="list-style-type: none"> 1. Deliver the fabricated and purchased components of the base, roller supports, base alignment components, and HCal supports to the AH 2. Assemble item 1 components 3. (lower portion of Outer HCal installed as described in section 1.10.03.04) 4. Install magnet mounting and alignment provisions 5. (SC Magnet and remainder of Outer HCal installed as described in sections 1.10.03.03 and 1.10.03.04) 6. Install upper platform support columns and bracing

7. (Magnet tests and mapping as described in 1.03)
8. Install Inner HCal Mounting supports
9. (other detector components installed as described in 1.10.03.05, 1.10.03.06, and 1.10.03.07)
10. Install Flux return end caps

Deliverable: None (Milestones for item completions and deliverables in WBS 1.09)

1. Project Title:	2. Date:	3. Person Responsible
SPHENIX	01/15/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10.03.03	sPHENIX SC Magnet Installation

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Labor and material costs for the Installation of the sPHENIX Superconducting Solenoid Magnet and ancillary equipment as described in the technical content below. All labor and material costs are based on engineering estimates.</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Installation and integration of the sPHENIX SC magnet into the CP including cryo and electric integration, alignment/survey to CP, and full field test/commissioning of the magnet.</p> <p><u>WORK STATEMENT:</u></p> <p>The steps required to undertake the assembly, installation and testing of the sPHENIX SC magnet are as follows:</p> <ol style="list-style-type: none"> 1. (complete steps 1-4 for WBS item 1.10.03.02) 2. Using the AH crane, spreader bar and appropriate sling (note: spreader bar previously procured for the magnet under WBS 1.03) lift the magnet onto its mounting provisions described in 1.10.03.02 and align with survey 3. (Install remainder of Outer HCal and CP upper platform with supports and bracing as described in sections 1.10.03.03 and 1.10.03.04) 4. Install SC magnet Stack 5. Move CP carriage to IR for testing

6. (connect SC magnet cryo and electrical power for full field test and magnet mapping as described in WBS 1.03)
7. Move CP back to AH for additional assembly
8. Install additional detectors and infrastructure components as described in 1.10.03.02 steps 7 through 10.)
9. Move CP back to IR
10. (connect SC magnet cryo and electrical power for run conditions and perform full field commissioning tests as described in WBS 1.03)

Deliverable: None (Milestones for item completions and deliverables in WBS 1.03)

1. Project Title:	2. Date:	3. Person Responsible
SPHENIX	01/15/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10.03.04	sPHENIX Outer HCal Installation

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Labor and material costs for the Installation of the Outer HCal Detector Subsystem as described in the technical content below. All labor and material costs are based on engineering estimates.</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Installation/integration of the Outer HCal detector into the CP, power control and signal integration and commissioning of the detector, including alignment to the nominal beamline orbit and the magnet.</p> <p><u>WORK STATEMENT:</u></p> <p>The steps required to install and align Outer HCal detector subsystem are as follows:</p> <ol style="list-style-type: none"> 1. Transport fully assembled and tested (as described in 1.07) Outer HCal modules in groups of 4 modules to AH and place on temporary holding racks. Use custom Outer HCal module lifting fixture to load and unload modules onto transport truck. 2. Test to make sure electronics are intact after transport. 3. Install scaffolding at north and south ends of CP base. 4. Lift, orient and install first Outer HCal onto CP base HCal cradle matching up index features. Survey to align to base. Use custom outer HCal lifting fixture to lift, orient and position the module into place. Use custom aligning tools to achieve desired alignment 5. Install the next 3 modules, one at a time in a similar manner to the first module,

- alternating the installation between the east and the west.
6. Repeat steps 1 through 4 until 16 modules have been installed and aligned.
 7. (Install the magnet as described in 1.10.03.03 steps 1 to 3)
 8. Install custom temporary Upper HCal support/alignment fixture
 9. Increase scaffolding for upper half of Outer HCal installation.
 10. Repeat steps 1 through 4 until all 32 modules are installed
 11. Test individual module electronics to assure that electronics have not been damaged during assembly
 12. Install patch panels, cable management hardware, cable trays for Outer HCal .
 13. Route Outer HCal cables and fibers to Outer HCal racks
 14. Test all connections
 15. Remove scaffolding.
 16. (other detector subsystem installation and CP moved into IR as described in other 1.10.03 subsystem installation descriptions)
 17. Commission testing for Outer HCal

Deliverable: None (Milestones for item completions and deliverables in WBS 1.07)

1. Project Title:	2. Date:	3. Person Responsible
SPHENIX	01/15/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10.03.05	sPHENIX Inner HCal Installation

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Labor and material costs for the Installation of the Inner HCal Detector Subsystem as described in the technical content below. All labor and material costs are based on engineering estimates.</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Installation/integration of the Inner HCal detector into the CP, power control and signal integration and commissioning of the detector, including alignment to the nominal beamline orbit and the magnet.</p> <p><u>WORK STATEMENT:</u></p> <p>The steps required to install and align Inner HCal detector subsystem are as follows:</p> <ol style="list-style-type: none"> Transport all 64 fully assembled and tested (as described in 1.07) Inner HCal modules and place on temporary holding racks. Use custom EMCal module lifting fixture to load and unload modules onto transport truck. Test to make sure electronics are intact after transport. Assemble the EMCal indexed insertion tool on the south side of the sPHENIX One by one Insert and align the 32 south EMCal modules Move the Rotate the Installation fixture to move the installed Inner HCal module to the bottom position

- g. Repeat steps 1 through 4 to install a Inner HCal module 2 positions away from the first module installed (leaving a single module gap)
- h. Continue this way until 8 modules have been installed,
- i. Transport an additional 8 modules to the AH
- j. Install these 8 modules as before with single module gaps on either side of each module. At this point all of the temporary standoffs will have been removed.
- k. Transport another 8 modules and install and align with adjacent modules, alternating between top and bottom to minimize variations in load distribution.
- l. Transport the final 8 modules, install and align as before rotating the fixture each time to maintain load distribution as evenly as possible around the detector.
- m. Make final alignment adjustments and secure end rings to lock all modules in place.
- n. (Install Inner HCal support rings (see WBS item 1.10.03.02)
- o. Install Inner HCal assembly installation I-beam and support, and attach to Inner HCal assembly fixture I-beam
- p. Remove assembly fixture support on I-beam extension end.
- q. Install the full Inner HCal, align and attach to the Inner HCal mounting supports.
- r. Install patch panels, cable management hardware, cable trays for Inner HCal .
- s. Route Inner HCal cables and fibers to Inner HCal racks
- t. Test all connections
- u. Remove scaffolding.
- v. (other detector subsystem installation and CP moved into IR as described in 1.10.03.06 and 1.10.03.07 subsystem installation descriptions)
- w. Commission testing for Inner HCal

Deliverable: None (Milestones for item completions and deliverables in WBS 1.07)

1. Project Title:	2. Date:	3. Person Responsible
SPHENIX	01/15/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10.03.06	EMCal Installation

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Labor and material costs for the Installation of the EMCal Detector Subsystem as described in the technical content below. All labor and material costs are based on engineering estimates.</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Installation/integration of the EMCal detector into the CP, power control and signal integration and commissioning of the detector, including alignment to the nominal beamline orbit and the magnet.</p> <p><u>WORK STATEMENT:</u></p> <p>The steps required to install and align EMCal detector subsystem are as follows:</p> <ol style="list-style-type: none"> Transport all 64 fully assembled and tested (as described in 1.07) Inner HCal modules and place on temporary holding racks. Use custom EMCal module lifting fixture to load and unload modules onto transport truck. Test to make sure electronics are intact after transport. Assemble the EMCal indexed insertion tool on the south side of the sPHENIX structure One by one Insert and align the 32 south EMCal modules using the indexed insertion tool. Move the EMCal indexed insertion tool to the north side of sPHENIX and

- reassemble
- f. One by one Insert and align the 32 north EMCal modules using the indexed insertion tool.
- g. Make final alignment adjustments and secure and lock all modules in place.
- h. Install patch panels, cable management hardware, cable trays for EMCal .
- i. Route EMCal cables, fibers and services to EMCal racks or service distribution manifolds as appropriate
- j. Test all connections
- k. (Tracker detector subsystem installation and CP moved into IR as described in 1.10.03.07 and 1.10.03.03 subsystem installation descriptions)
- l. Commission testing for EMCal

Deliverable: None (Milestones for item completions and deliverables in WBS 1.06)

1. Project Title:	2. Date:	3. Person Responsible
SPHENIX	01/15/2015	D. Lynch

4. WBS Element Code	5. WBS Element Title
1.10.03.07	Tracker Installation

6. Index Line Number:	7. Revision Number and Authorization:	8: Rev. Date

9. Approved Changes

10. Element Task Description
<p><u>COST CONTENT:</u></p> <p>Labor and material costs for the Installation of the Tracker Detector Subsystem as described in the technical content below. All labor and material costs are based on engineering estimates.</p> <p><u>TECHNICAL CONTENT:</u></p> <p>Installation/integration of the Tracking detector into the CP, power control and signal integration and commissioning of the detector, including alignment to the nominal beamline orbit and the magnet.</p> <p><u>WORK STATEMENT:</u></p> <p>The steps required to install and align Tracker detector subsystem are as follows:</p> <ol style="list-style-type: none"> Transport both fully assembled and tested (as described in 1.05) Tracker halves and place on temporary holding racks. Use custom Tracker half lifting fixture to transport halves to AH Test to make sure electronics are intact after transport. Assemble the Tracker support rails Install both Tracker halves on the rail and align the halves to each other

- e. Move the Tracker halves to its run position inside the magnet and other detectors
- f. Make final alignment adjustments and secure and lock the Tracker in place.
- g. Install patch panels, cable management hardware, cable trays for Tracker .
- h. Route Tracker cables, fibers and services to Tracker racks or service distribution manifolds as appropriate
- i. Test all connections
- j. (CP moved into IR as described in 1.10.03.07 and 1.10.03.03 subsystem installation descriptions)
- k. Commission testing for Tracker

Deliverable: None (Milestones for item completions and deliverables in WBS 1.05)